



The Role of Natural Gas in the Transition to a Hydrogen Economy

**Presented by
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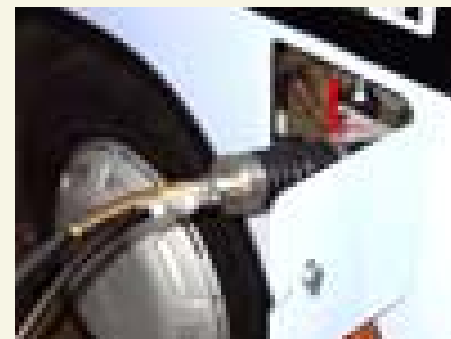
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CA Hydrogen Highway Economy Team Presentation



Leveraging Experience

- Who is Clean Energy?
- Why hydrogen & natural gas?
- Four fundamentals for a successful and rapid transition
- Action today



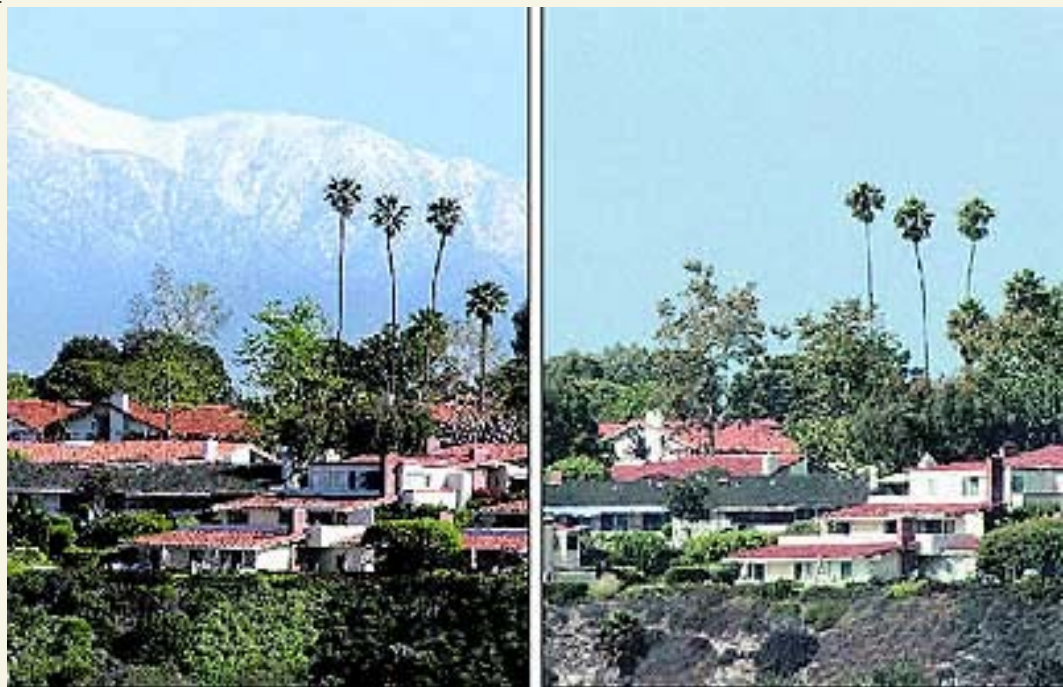


Clean Energy – A Brief Overview

- Headquartered in Seal Beach, CA
- Operate over 160 natural gas stations throughout North America
- Design/develop H₂ stations
- Experienced in all facets of transitioning to gaseous fuels
- Know the players and their roles

Why Hydrogen?

- Diminishing oil supplies
- Air quality
- Greenhouse gases and climate change
- National security
- Public health
- Balance of trade



Four Fundamentals for a Rapid and Successful Transition



Daimler Chrysler Ncar FCV

- Infrastructure
- Vehicles
- Policy
- Funding



Transition Fundamental 1: H₂ Infrastructure

- Long-term: H₂ from renewables
- Near-term: H₂ from natural gas (DOE)
- Renewables vs. reforming:
 - Reduce wind by factor of 3
 - Reduce solar by factor of 10
 - Others
 - Biogas, etc.



Infrastructure

Natural Gas Reforming



- Reformed on-site
 - Central / Distributed
 - At CNG stations
- Purified to meet fuel cell (FC) specs ?
- Compressed, stored, metered, dispensed into HICE and FC vehicles



California Hydrogen Highway

Of note, the state's first public access hydrogen station is co-located with a natural gas station at SunLine Transit Agency in the Coachella Valley.





California's Natural Gas Stations

Reality check!



Map available at <http://www.cngvc.org/ngv/cngvc.nsf/bytitle/cal.htm>



Infrastructure Growth

Early Development

- Initial NG station development
 - Strong support from utilities, oil companies, private firms
 - Utilities built about 100 stations
 - Siting & Cost
 - Access
 - Changing Standards
 - Pressure
 - Dispensers
 - Fuel Quality
 - Private Sector Station Developers



Infrastructure Growth Business Case

- Realization of anchor tenant model
- Reality check
 - Today's leading NG station & equipment firms are the backbone for tomorrow's H₂ stations
 - Without NG growth, industry can't support H₂ growth



Co-Location Leverages Land and Awareness

- Efficient Land Use
 - Development
 - Permitting, etc
 - Operations
- Public Awareness
- Location³ vs. Profitability³



Transition Fundamental 2: Vehicles

- Fuel cells – the long range goal
- HICE's – a near term goal
 - Similar challenges to NG
 - New vehicle development
- NGVs – available now
 - Light, medium, heavy-duty
 - Fleets vs. consumer





Gaseous Fuel Platforms Market Penetration

- Transit
- Refuse
- Airports
- Municipal
- Regional Trucking

Transit





Beijing Success Story



- 1990 natural gas buses make it the largest LBSI CNG bus fleet in the world
- Running 18 hr per day, 7 days per week
- 90% of 18,000 bus fleet to be operating on “clean engines” by 2008 Olympics



Transit Customers

- SunLine Transit
- Foothill Transit
- San Diego MTDB
- City of Phoenix
- Valley Metro RPTA
- Tempe Transit
- Denver RTA
- Fort Worth Transit
- MBTA – Boston
- Variety of Airport Transit Operations



Pierce Transit – Success Story



- Operating in Tacoma, WA
- In 1990, Pierce Transit introduced their first natural gas bus
- By 2005, Pierce Transit intends to operate only buses that run solely on compressed natural gas (CNG) – currently operate 176 NG buses
- Natural gas operating costs for Pierce's latest delivery of C Gas Plus engines (2002 MY) were \$0.36 per mile compared to \$0.57 per mile for diesel operating costs



C Gas Plus Satisfaction Survey Customer Ranking

- Majority of customers rated the C Gas Plus excellent or good on 7 of 8 criteria.
 - » **Low Emissions**
 - » **Ease of Servicing**
 - » **Safety**
 - » **Driver Satisfaction**
 - » **Low Noise Levels**
 - » **Availability of Parts**
 - » **Frequency of Engine Breakdowns**
- Engine is rated by 88% of customers as an improvement over its predecessors C8.3G and L10G.
- 70% of managers reported that the C Gas Plus has improved their perception of natural gas engines overall.
- 90% of managers are likely to repurchase the C Gas Plus

Natural Gas Refuse Truck Chassis





Waste Management Refuse Truck



Recycling Truck





Refuse Trucks : Fast Facts

- Average truck logs twice many miles as typical single-unit heavy duty truck; three times average bus
- Use more fuel annually than all other vehicles except tractor trailers
- 61% travel under 200 miles per trip and refuel at central station
- Offer highest potential for significant air quality, public health and energy benefits
- Proven technology

Los Angeles International Airport



Port of Seattle (SeaTac)



Denver International Airport





Clean Energy Current Airport Customers

- Los Angeles Int'l
- Burbank
- John Wayne
- Palm Springs Int'l
- San Diego
- Oakland
- La Guardia
- Tucson
- Seattle (SeaTac)
- San Francisco Int'l
- Phoenix Sky Harbor West and East
- Denver Int'l
- DFW
- Love Field



Airport Taxi Policies & Incentives Summary

- Phoenix Sky Harbor
 - All airport carriers & fleet must be 100% alternative fuels
- LAX & SoCal Airports
 - All fleets >15 vehicles must be ULEV when adding or replacing vehicles, SCAQMD buys down all taxis servicing airports to \$10,000 plus tax
- SFO and Oakland
 - Front of the line privileges, trip fee reductions, HOV access with driver only, Airport sponsored BAAQMD funding
- SeaTac
 - Taxis must convert to 100% CNG over the next 3 years, 70% of Shared Ride Shuttle trips must be on CNG
- DFW
 - 100% of fleet & rental car shuttles must be Alt Fuel, 100% of all taxi, shuttle, limo, towncar and shared ride vehicles must be ULEV or equivalent by 2007
- DIA
 - AFV requirement for 100% of airport fleet, all rental cars must be CNG, 25% discount on airport entrance fees



Benefits of Hydrogen/ Natural Gas Blends

- Collier Technologies / Daewoo – Achieve 2010 Std
- Westport Innovations testing blended fuel in lean-burn spark-ignited CWI transit bus engines
- Emissions data encouraging – 50% reduction in NO_x
- Technology exists at affordable price
- Creates a market for H₂ now and reason to develop infrastructure



Fleet Implementation

- Top Down Leadership
- Fuel cost is critical
- Vehicles to meet Mission
- Facility modifications
- Employee training is key to success!
 - From liquid to 3,600 psi
 - From 3,600 psi to 5,000 – 10,000 psi
 - Cryogenic Fuels
- Societal experience



Transition Fundamental 3: Policy

- Fundamental societal change
 - Driven by extremes or with policy
 - Fuel neutrality = No progress
 - Requires real leadership & commitment
- SCAQMD Fleet Rules
 - Vehicle development & sales
 - Air quality benefits
 - Accelerate the shift to gaseous fuels



Transition Fundamental 4: Funding

- \$\$ needed to offset start-up costs
 - Infrastructure - to supplement fuel sales
 - Vehicles –to offset incremental costs
 - Other – for facility modifications & training
- Money will help drive change. But alone ... it's too slow to be meaningful!





The Transition: Natural Gas to H2

- NG is ready today and is a driver for H2 tomorrow
- 3,317,036 natural gas vehicles
- 6,629 refueling stations
- 8,055 NG vehicle refueling appliances
- 16,200 CNG buses in Beijing alone by 2007
- Less than 100 hydrogen vehicles worldwide

Source: International Natural Gas Vehicle Coalition

A common voice accelerates the shift to Clean Fuels!

- Leveraging gaseous fuel opportunities = REAL progress!
 - Infrastructure - Co-locate
 - Vehicles - New/better designs
 - Policy - Required for transition
 - Funding - Essential for market penetration



Sample Actions for Today

- Implement State & CARB policy
 - Require all state fleets & DOT to purchase only NGVs and H₂ vehicles when ready
 - Amend & implement NG Transit Rule
 - Implement NG Refuse Truck Rule
 - Implement NG Regional Truck Rule
- Require land be allocated sufficient for public fueling of both NG and H₂





Thank you from Clean Energy!

Questions?

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